13/Appeal Brief
T. Steptoe
1/20/01

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application of

Applicant : Jigish D. Trivedi
Serial No. : 08/915,658
Filed : August 21, 1997
Title : LOW RESISTANCE METAL SILICIDE LOCAL INTERCONNECTS AND METHOD OF MAKING
Docket : MIO 0024 PA
Examiner : G. Peralta
Art Unit : 2814

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

CERTIFICATE OF MAILING
I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Assistant commissioner for Patents, Washington, D.C. 20231, on January 2, 2001.

Attorney Reg. No. 29,001

BRIEF ON APPEAL

This is an appeal from the Office Action mailed August 1, 2000, finally rejecting claims 31-40. A Request for Reconsideration After Final Rejection was timely filed on October 31, 2000. A Notice of Appeal was also timely filed on October 31, 2000. An Advisory Action stating that the Request for Reconsideration After Final Rejection was unpersuasive was mailed on December 4, 2000. Our check in the amount of $310.00 accompanies this Brief. 37 CFR §1.17(c).

Real Party In Interest

The real party in interest is the assignee of this patent application, Micron Technology, Inc., by assignment from the named inventor, which assignment has been recorded.

Related Appeals and Interferences

Applicant knows of no related appeals or interferences which would affect the outcome of the present appeal.

Status of Claims

Claims 31-40 are present in this patent application. Claims 31-40 stand finally rejected. Accordingly, claims 31-40 are before this Board on appeal. A correct copy of the appealed claims appears as an Appendix to this Brief. Claims 1-30 have been withdrawn pursuant to a restriction requirement.

Status of Amendments

No amendments to the claims after final rejection were filed. All previous amendments have been entered.

Summary of the Invention

Applicant's invention is directed to a local interconnect, and, more particularly, to a low resistance local interconnect having a refractory metal silicide. See the specification, Background at p. 1. Referring to Figs. 3-7 and the specification at pp. 12-13, the metal silicide 34 is patterned to form the boundaries of the local interconnect (p. 12, ll. 12-29 and p. 13, ll. 1-5) and then reacted with the underlying layer of metal 32 (p. 13, ll. 6-24). Silicon from the metal silicide 34 combines with the underlying metal 32 to form another metal silicide.

An intermetallic compound 37 comprised of metal from the underlying metal layer 32 and metal from the metal silicide 34 is also formed. In the preferred embodiment which is described, the intermetallic compound is titanium-tungsten (TiW) (p. 13, ll. 15-16). "The intermetallic compound of TiW reduces the resistance of the local interconnect while also increasing its adhesions characteristics" (p. 13, ll. 16-17). Other metals and intermetallic compounds are contemplated for use in the invention (p. 14, ll. 11-19). Unreacted metal from the underlying metal layer 32 is removed to form the local interconnect (p. 13, ll. 25-29). The metal silicide also serves as a contact etch stop during subsequent contact formation thereby allowing for a smaller local interconnect (p. 3, ll. 1-3).

Issues Presented

The issues presented for review on appeal are:

(1) Did the Examiner err in rejecting claims 31-34 as being unpatentable under 35 U.S.C. §102 over Okamoto?

(2) Did the Examiner err in rejecting claims 35-40 under 35 U.S.C. §103(a) as being unpatentable over Okamoto in view of Shepard?

To arrive at a conclusion on issue 2, the Board must also address the following issue:

(3) Has the Examiner carried her burden of establishing a prima facie case by showing that the teachings of the references are properly combinable and that there existed in the prior art proper motivation and an expectation of success?

Grouping of Claims

The Examiner has made two separate grounds of rejection based on the prior art as outlined above: claims 31-34 as being unpatentable under 35 U.S.C. §102 over Okamoto and claims 35-40 as being unpatentable under 35 U.S.C. §103 over Okamoto in view of Shepard. Applicant will argue the patentability of claim 31 as representative of claims 31-34 because the issues of novelty and whether the Examiner has carried her burden are believed to be the same for dependent claims 32-34. Applicant will argue the patentability of claim 35 as representative of claims 35-40 because the issues of obviousness and whether the Examiner has carried her burden of establishing a prima facie case of obviousness are believed to be the same for claims 36-40 on appeal.

The References

Okamoto, U.S. Patent No. 4,910,578:

A semiconductor device is taught where a ternary silicide film may be formed. Referring to Figs. 4A-4D, the formation of the semiconductor device includes the deposition of a titanium silicide film 4 onto the surfaces of impurity diffusion layers 5,7. A molybdenum silicide film 8 is then formed on the titanium silicide film 4. Finally, a titanium nitride film 10 is formed on the

molybdenum silicide film 8. Due to heat treatment needed for forming the impurity diffusion layers 5,7, a metallurgical reaction "may" occur between the titanium silicide film 4 and the molybdenum silicide film 8 to form a ternary silicide film. The formation is dependent upon the thickness of the two films and the temperature and time for the heat treatment. See Okamoto, col. 5, lines 35-41. Figs. 4A-4D illustrate the formation of ternary silicide film 30 depending upon those parameters.

Shepard, U.S. Patent No. 5,227,333:

A process for making a local interconnection of devices on a semiconductor substrate using a germanium layer is taught. Referring to Fig. 6, on the substrate 60, contact openings 66, 67 define a plurality of devices. A layer of germanium 74, then a layer of electrically conducting material 76 are deposited over the substrate 60. Both the germanium layer 74 and the electrically conducting material layer 76 are etched. The device can be a field effect transistor that possesses diffused source and drain regions with contact openings to the drain regions. See Shepard at col. 4, lines 10-13.

Summary of the Argument:

Claims 31-34 are not anticipated by Okamoto because Okamoto teaches at best the formation of a ternary silicide layer whereas applicant's invention teaches and claims the formation of "an intermetallic compound comprising metal from said first metal silicide and metal from said second metal silicide." Okamoto in view of Shepard does not render the subject matter of claims 35-40 obvious because the reference teachings are not properly combinable. Each is directed to a different process, and even if combined the reference teachings would still not teach or suggest the claimed subject matter. Thus, the Examiner has not carried her evidentiary burden of proof, and claims 31-40 should be allowed.

ARGUMENT

I. **Claims 31-34 are patentable over Okamoto.**

Applicant respectfully points out that the Examiner stated in the Advisory Action (Paper No. 12) that Okamoto "renders the claims obvious." Therefore, Applicant is unsure whether the Examiner has withdrawn the rejection of claims 31-34 under 35 USC §102 and has instituted a new ground of rejection. As the Examiner made no explicit statement that the ground stated in the final rejection had been withdrawn, Applicant will argue the rejection stated in the final rejection.

A rejection for anticipation requires that the cited reference must teach every element of the claim. MPEP §2131. "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. V. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). "The identical invention must be shown in as complete detail as is contained in the claim." *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

Claim 31 recites a local interconnect whose composite structure comprises "a first metal silicide, a second metal silicide, and an intermetallic compound comprising metal from said first metal silicide and metal from said second metal silicide." The claimed intermetallic compound results from an annealing step in the formation process. See, p. 13, ll. 6-10. The resulting intermetallic compound, TiW in the preferred embodiment, results in advantageous properties for the local interconnect, specifically reducing the resistance of the interconnect while increasing adhesion characteristics. See, p. 13, ll. 16-17.

Okamoto clearly states in col. 5, lines 35-41, that a metallurgical reaction **may** take place between the titanium silicide film and the molybdenum film and form a **ternary silicide film**. Whether such a metallurgical reaction occurs is dependent upon the thickness of the two films, the temperature, and the time for the heat treatment. Okamoto does not mention expressly or inherently the formation of an **intermetallic compound** from two different metals in different

metal silicide layers. Rather, Okamoto teaches the possible formation of a **ternary silicide film** from the reaction that may take place between two films during the formation of the impurity diffusion layer.

Applicant has asserted that the claimed "intermetallic compound" should be construed as one skilled in this art would construe the term. Applicant argued in his Request for Reconsideration after Final Rejection that the Encyclopedia Britannica defines "intermetallic compound" as:

> any of a class of substances composed of definite proportions of two or more elemental metals, rather than continuously variable proportions (as in solid solutions). The crystal structures and the properties of intermetallic compounds often differ markedly from those of their constituents. In addition to the normal valences of their components, the relative sizes of the atoms and the ration of the total number of valence electrons to the total number of atoms have important effects on the composition of intermetallic compounds.

In addition, Applicant pointed out that The Academic Press Dictionary of Science and Technology defines "intermetallic compound" as:

> *Metallurgy*. An intermediate phase in which the components are metallic; for instance nickel aluminide.

Further, applicant's claims do not simply recite an "intermetallic compound," but rather an "intermetallic compound comprising **metal** from said first metal silicide and **metal** from said second metal silicide." (Emphasis supplied)

Okamoto does not teach the formation of an "intermetallic compound" in film 30. Rather, as explicitly taught by Okamoto, film 30 comprises a titanium molybdenum silicide compound, $Ti_xMo_ySi_z$. See, col. 5, lines 35-41 and 60. Therefore, Okamoto teaches a ternary silicide film 30, not an intermetallic compound as claimed. A ternary silicide does not meet the definition of an intermetallic compound.

In response to Applicant's reliance upon the ordinary meaning of the claim terminology, the Examiner, in the Advisory Action (Paper No. 12) cited to Merriam-Webster's Collegiate Dictionary which defines the word "intermetallic" as being "composed of two or more metals or a metal and a nonmetal; esp: being an alloy having a characteristic crystal structure and usually a

definite composition." The Examiner asserted that a compound consisting of tungsten, titanium and silicon is included in the above definition "and thus Okamoto renders the claims obvious for the reasons stated in the Final Rejection, Paper 9."

There are two fatal deficiencies in the Examiner's analysis. First, the Webster's definition is for the word "intermetallic," not the claimed "intermetallic compound." Even Webster's provides as an example an alloy which must contain two or more metals. Moreover, any person having scientific expertise or skill would recognize that at least part of the Webster's definition is incorrect. According to Webster's, a compound of a metal and a non-metal is considered to be "intermetallic." Thus, according to Webster's, common metal oxides such as TiO_2, Al_2O_3, Fe_3O_4 and the like would be understood to be "intermetallic." However, this is contrary to common nomenclature and understanding in the chemical arts as the Examiner and this board must be well aware.

The second fatal deficiency in the Examiner's analysis is that it ignores the totality of the claim language. Applicant is not simply claiming an "intermetallic compound," but rather one which comprises **metals** from two different metal silicide layers. An example of such an intermetallic compound in applicant's specification is titanium tungsten (TiW). Nowhere does Okamoto teach or suggest the formation of an "intermetallic compound which comprises metals from two different metal silicide layers."

Summarizing, Okamoto explicitly teaches the formation of a ternary silicide, not an intermetallic compound. There is nothing in Okamoto which even remotely suggests the formation of an intermetallic compound as claimed. Col. 5, lines 35-41 and 60 only teach the possible formation of a ternary silicide. Neither the phrase "intermetallic compound" nor the definition is even used or referred to in the patent. And, the Webster's dictionary definition relied upon by the Examiner is flawed in that it is directed to a different term and is incorrect as a matter of common understanding in the chemical arts.

II. **Establishing a prima facie case of obviousness.**

In order to establish a prima facie case of obviousness, the Examiner has the burden of showing, by reasoning or evidence, that: 1) there is some suggestion or motivation, either in the reference itself or in the knowledge available in the art, to modify that reference's teachings; 2) there is a reasonable expectation on the part of the skilled practitioner that the modification or combination has a reasonable expectation of success; and 3) the prior art reference or combination of references must teach or suggest all of the claim limitations. Both the teaching or suggestion and the reasonable expectation of success must be found in the prior art and not based on an applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991); see also, MPEP §2142.

In carrying this burden, the Examiner "must present a convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious." *Ex parte Clapp*, 227 USPQ 972, 973 (PTOBPAI 1985). A rejection based on §103 clearly must rest on a factual basis, and these facts must be interpreted without hindsight reconstruction of the invention from the prior art. *In re Warner*, 154 USPQ 173, 178 (CCPA 1967). The Examiner may *not*, because she may doubt that the invention is patentable, resort to speculation, unfounded assumptions, or hindsight reconstruction to supply deficiencies in his required factual basis. *Id.*

III. **Okamoto does not render obvious the subject matter of claims 35-40.**

In light of the confusion surrounding the Examiner's Advisory Action, Applicant will argue the unobviousness of claims 35-40 under 35 U.S.C. §103 over Okamoto. As stated above, Okamoto teaches the possible formation of a ternary silicide. There is absolutely no teaching, suggestion, or motivation to create an intermetallic compound. In addition, a ternary silicide does not qualify as an intermetallic compound for the reasons stated above. Therefore, Okamoto cannot render obvious claims 35-40 of the present invention which clearly recite the presence of an intermetallic compound which comprises metals from two different metal silicide layers.

IV. **Okamoto taken in view of Shepard does not render obvious the subject matter of claims 35-40.**

In the final rejection, the Examiner rejected claim 35-40 under 35 U.S.C. §103 as unpatentable over Okamoto in view of Shepard. This rejection was clearly based on the Examiner's incorrect assertion that Okamoto teaches the formation of an intermetallic compound. As shown above, Okamoto does not teach the formation of an intermetallic compound with two different metals. Rather, Okamoto teaches the possible formation of a ternary silicide. The rejection is deficient for that reason.

Moreover, one of ordinary skill in the art would not think to combine the teachings of Okamoto with those of Shepard. Shepard was cited for its teaching of a field effect transistor structure having a local interconnect. A germanium layer and a layer of electrically conducting material are used to create the local interconnect. Although Shepard does teach the formation of a local interconnect on a field effect transistor, Shepard uses a completely different process to create a local interconnect having a germanium layer. Thus, the teachings of Okamoto would not be properly combinable because a completely different semiconductor device is taught using different materials. Furthermore, no motivation or suggestion exist in either Shepard or Okamoto to combine their teachings.

Even if one were to concede that the teachings of Okamoto and Shepard were properly combinable, the claimed invention still would not result. As discussed in detail above, Okamoto does not teach or suggest the formation of an intermetallic compound as that term is understood by those skilled in the art. Neither does Shepard. Therefore, claims 35-40 are patentable for the same reasons that claims 31-34 are patentable.

V. **Conclusion**

For all of these reasons, Applicant submits that the rejections are not well taken and all rejections of claims 31-40 should be reversed in their entirety by this Board.

Respectfully submitted,

KILLWORTH, GOTTMAN, HAGAN
& SCHAEFF, LLP

By _____
Timothy W. Hagan
Registration No. 29,001

One Dayton Centre
One South Main Street, Suite 500
Dayton, Ohio 45402-2023
(937) 223-2050
Facsimile: (937) 223-0724
E-mail: hagant@kghs.com
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APPENDIX

31. A local interconnect comprising:

a composite structure comprising a first metal silicide, a second metal silicide and an intermetallic compound comprising metal from said first metal silicide and metal from said second metal silicide.

32. The local interconnect of claim 31, wherein said first metal silicide and said second metal silicide each comprise at least one refractory metal.

33. The local interconnect of claim 32, wherein said at least one refractory metal for said first metal silicide and said second metal silicide is selected from the group consisting of chromium, cobalt, molybdenum, nickel, niobium, palladium, platinum, tantalum, titanium, tungsten, and vanadium.

34. The local interconnect of claim 32, wherein said first metal silicide comprises titanium silicide and said second metal silicide comprises tungsten silicide.

35. A local interconnect for connecting a first active semiconductor region to a second active semiconductor region on a substrate assembly, said first and second active semiconductor regions being separated by an insulating region, said local interconnect comprising:

a composite structure comprising a first refractory metal silicide, a second refractory metal silicide and an intermetallic compound comprising refractory metal from said first refractory metal silicide and refractory metal from said second refractory metal silicide, said refractory metal from said first refractory metal silicide being different from said refractory metal from said second refractor metal silicide.

36. The local interconnect of claim 35, wherein said composite structure has a thickness in the range of about 700 Angstroms to about 1800 Angstroms.

37. A semiconductor device comprising:

a substrate assembly having at least one semiconductor layer;

at least one field effect transistor formed in said at least one semiconductor layer, said least one field effect transistor having a source, a drain and a gate; and

a local interconnect for connecting at least one of said source, said drain and said gate to another active area within said substrate assembly, said local interconnect comprising a composite structure comprising a first refractory metal silicide, a second refractory metal silicide and an intermetallic compound comprising refractory metal from said first refractory metal silicide and refractory metal from said second refractory metal silicide.

38. A memory array comprising:

a plurality of memory cells arranged in rows and columns and formed on a substrate assembly having at least one semiconductor layer, each of said plurality of memory cells comprising at least one field effect transistor; and

at least one local interconnect for connecting at least one of a source, a drain and a gate of said at least one field effect transistor in one of said plurality of memory cells to one of an active area within said one memory cell or to one of a source, a drain and a gate of said at least one field effect transistor in another one of said plurality of memory cells, said local interconnect comprising a composite structure comprising a first refractory metal silicide, a second refractory metal silicide and an intermetallic compound comprising refractory metal from said first refractory metal silicide and refractory metal from said second refractory metal silicide.

39. The memory array of claim 38, further comprising a plurality of local interconnects for connecting additional active areas within each of said plurality of memory cells.

40. The memory array of claim 38, further comprising a plurality of local interconnects for connecting together active areas from different memory cells.